# PATHWAYS OF HUMAN EXPOSURE IN OU4

## Conceptual Site Model

The first step in developing a risk assessment at a site or an Operable Unit is usually the development of a conceptual site model (CSM). The purpose of a CSM is to organize and graphically display likely sources of contaminants, mechanisms of contaminant release to the environment, likely pathways by which contaminants may be migrating in the environment, and likely routes by which humans might come into contact with contaminants in the environment (USEPA 1989). The CSM then helps guide initial investigations on the nature and extent of contamination at the site, and may be updated or revised periodically during the course of the site investigation as more data become available.

As discussed previously, [Note to TAU...I will add the draft text of Section 1.4 that defines OU4 along with a map once I receive the info from CDM] this risk assessment focuses on exposure pathways that apply to residents and workers who reside, work, or attend school in or about the community of Libby (OU4). This includes an assessment of exposures in Libby at properties that have been cleaned up and also at those properties that have not been cleaned up. For properties that have been cleaned up, both pre-cleanup and post-cleanup conditions will be assessed. For properties that have not been cleaned up, exposures will be assessed as pre-cleanup (current) conditions.

As noted previously, the contaminant of concern in OU4 is a form of asbestos referred to as Libby amphibole (LA). Figure 4-1 presents a conceptual model for human exposure to LA at the site. This model has been developed based on EPA's current understanding of sources and likely pathways of transport or migration and potential human exposure to LA in OU4. Because inhalation of LA fibers in air is the primary exposure route of concern, only inhalation pathways are included in this CSM. Exposure to LA by ingestion of contaminated soil, sediment, dust, or water might also be occurring at the Libby site, but these exposure pathways are currently believed to be a minor source of health risk compared to the inhalation pathways.

Not all inhalation exposure pathways to LA shown in Figure 4-1 are likely to be of equal concern. In the figure, a black dot is used to show exposure pathways that are considered the most likely to be complete and significant for each receptor, and where a quantitative assessment of risk will be performed. In a quantitative assessment, data from the site are used to derive numeric estimates of the magnitude of health risk in exposed people. Boxes with an open circle indicate exposure pathways that may be complete, but these exposures are believed to be minor compared to other exposures that are occurring, and are assessed by presenting qualitative information on the relative magnitude (e.g., negligible, small, moderate) of the exposure compared to the total exposure. This approach, termed a qualitative evaluation, may not only include these relational comparisons of exposure but may also assess the strength of evidence for each of those

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exposures and rank them individually for use in the qualitative evaluation (i.e, IRIS weight-of-evidence approach). Boxes with a question mark indicate pathways that may be complete, but where current data are not sufficient to judge whether the pathway is likely to be significant. EPA will seek to collect additional data in the future to allow evaluation of these pathways. Boxes that are open (no symbol) indicate that the exposure pathway is not complete, or if complete, is likely to be negligible.

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Other exposure pathways that may also be of concern at the Site will be evaluated during on-going investigations and evaluations for the other OUs at the site. For example, it is anticipated that the evaluation for OU3 (the mine) will include an assessment of exposures of workers and recreational visitors in forests and other public areas near the mine, and will also include assessments of exposures associated with releases along highway and railroad transportation corridors (e.g., Rainy Creek Road, Highway 37, etc.). Likewise, mine-related exposures that occur in and about the community of Troy will be evaluated as part of OU7.

### 4.1.1 Sources of LA Asbestos

Ultimately, all pathways of exposure to LA in and about the community of Libby may be traced back to the mine and the mining, milling, and production operations associated with the mine. It is believed that the most important sources causing past and/or current releases of LA into the environment include the following.

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1. *Mine, Mill, and Processing Facilities*. When the mine, mill, and processing facilities were operating, activities at these locations released LA fibers into the air (MRI 1982). Although the mine and processing facilities are no longer operating, airborne release of fibers from exposed asbestos-contaminated soils, exposed ores, or other contaminated outdoor surfaces at these facilities is likely still occurring, albeit at a lower rate than in the past.

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2. *LA Contaminated Surface Soils and Outdoor Surfaces*. Airborne fibers released from the mine, mill, and processing facilities would have been carried by the wind in a down wind direction. Most fibers likely would fall to earth and lead to contamination of surface soils, surface water, and other exposed surfaces (e.g., some fibers may have been trapped in tree bark or deposited on surfaces of buildings, streets, etc.).

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3. *Solid Wastes*. Solid wastes generated at the former mine site or at milling and processing sites (the screening plant and the two export plants) may also be a source of past and/or current releases to the environment. In some cases, solid waste materials were used as fill or soil amendments in residential yards, gardens, and driveways. Solid waste materials also may have been used around public facilities, such as schools and ball fields, resulting in direct exposures through recreational activities. Solid waste product may have spilled during transport and contaminated the margins of transportation corridors such as roads and rail lines.

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4. *Vermiculite Product*. Product from the mine (unexpanded or expanded vermiculite) was used as insulation in a number of buildings as well as a soil amendment in residential yards, gardens, driveways, etc. in Libby. Because Libby vermiculite contains LA as a contaminant, the vermiculite insulation, if it exists in an unenclosed space, can serve as a continuing source of exposure to residents or workers who may come into contact with the vermiculite. If used as a soil amendment, vermiculite product may also represent a continuing source of exposure. Vermiculite product also may have been used around public facilities, such as schools and ball fields. Additionally, in some cases, vermiculite product may have spilled during transport and contaminated the margins of transportation corridors.

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4.1.2 Migration Pathways in the Environment

Because asbestos is a solid, once it is released into the environment, it will generally tend to stay in place. However, there are three main ways by which LA may be transported within OU4:

1. *Airborne Transport.* Because LA fibers are small, airborne suspension may result from release mechanisms such as wind or mechanical disturbances (e.g., physical disturbance, vehicular and foot traffic, etc.). Once airborne, LA fibers will tend to move with the air. The time that the fibers remain in air (and hence the distance they may move before returning to earth) depends on the size of the particle and air flow turbulence, and may range from only a few minutes to a number of hours (USEPA 1985).

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2. *Surface Water Transport*. Although asbestos is not soluble in water, suspended particles may be carried in surface water runoff (e.g., from rain or snowmelt) from the mine or other areas where soil is contaminated by LA, and deposited in soils or sediments at downstream locations. Fibers may then be released to the air from contaminated soils or dried sediments by either wind or mechanical disturbances.

3. *Bulk Transport*. Vermiculite and solid wastes that contain vermiculite or LA can be hauled from one place to another by humans for use in a variety of applications (e.g., fill or soil amendments in yards or gardens). In contrast to airborne and surface water transport pathways, whose impacts can often be reasonably well understood and predicted, the bulk transport pathway can result in the occurrence of asbestos contamination in nearly any location. In addition, contaminated soil and other similar material may be transported inadvertently by adherence to shoes or clothing, and can lead to contamination of dusts in homes, workplaces, schools, and vehicles.

4.1.3 Populations Evaluated in OU4

The OU4 risk assessment includes an evaluation of the following human populations that are likely to be exposed in and about the main residential and commercial areas of Libby:

- Residents. This includes children and adults who live in homes within the boundaries of OU4.
- Commercial Workers. This includes individuals who primarily work inside shops, stores, and other businesses located within the boundary of OU4. This population does not include people who work in Libby only occasionally or intermittently (as opposed to full time).
- Tradesperson. This includes people such as plumbers, electricians, home repair contractors, yard care workers, municipal workers, etc., who work at homes or businesses within the boundaries of OU4 on a regular basis and who may have contact with vermiculite insulation in indoor locations or contaminated soil in outdoor locations.
- Students/Teachers. This includes children who regularly attend school in Libby, along with the teaching and administrative staff at those schools.
- Recreational Visitors. This includes people who regularly engage in recreational or athletic activities at public lands (parks, open space) or facilities (ball fields, tracks, etc.) located within the boundaries of OU4. It is understood that most of these individuals may also be residents of Libby. Risks to out-of town visitors or tourists who visit the site and engage in recreational activities will be estimated from those computed for area residents, by adjusting for differences in exposure frequency and duration.

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#### 4.1.4 Exposure Scenarios Evaluated in OU4

Based on our current understanding of the past and present sources of release and transport of LA from the mine, the media and pathways that are believed to be the most likely to serve as important sources of human exposure in OU4 include the following:

1. *Breathing Outdoor Ambient Air.* Although general ambient air may be impacted by any activity that causes LA to be released from a source, it is currently believed that the main source of LA in general outdoor ambient outdoor air in the vicinity of Libby is release from contaminated soil in and around the community. This is because contaminated soils occur in multiple locations in and around Libby, and can serve as a continuous source of LA release into the air. Releases of LA from soil into outdoor ambient air may be due either to wind blowing over the soil, or from a variety of disturbances of the soil by human activity. Other sources that may impact outdoor ambient air include contaminated soil and waste at the mine site itself, and disturbances of LA from outdoor surfaces where it has accumulated, such as the burning of wood that has LA in the bark.

2. *Breathing Indoor Air.* Indoor air exposures to LA may be divided into two main categories: 1) those that occur on a regular basis in the main living spaces of the home, workplace, or school, and 2) those that occur intermittently when someone enters into a non-living space such as an unfinished attic with unenclosed vermiculite.

The *main living space* of a home, business, or school may become contaminated by several alternative pathways, including: 1) leaking vermiculite insulation (if present) from walls or attics; 2) transport of contaminated outdoor soil into indoor dust *via* shoes, clothing, pets, etc.; and 3) transport of contaminated wood indoors for burning. Once in indoor dust, LA may become suspended in indoor air by disturbance of the indoor dust by mechanical forces (air flow from heating or cooling systems) and a variety of normal human indoor activities (walking, playing, cleaning, etc.).

In an *unfinished attic space* (non-living space) that contains unenclosed vermiculite insulation, nearly any activity that disturbs the insulation is likely to cause a release of vermiculite and LA fibers into the air of the attic. This pathway is likely to occur intermittently for residents who visit an unfinished attic space to place or retrieve stored items, but may be fairly common for a tradesman who must enter such spaces to perform repairs on plumbing, wiring, etc.

LA contained behind enclosed walls etc. does not present an open pathway for human exposure, however, breaches in the containment by various activities can result in airborne exposures and contamination to indoor dust. It is currently believed that such exposures are of concern primarily for tradesmen (carpenters, electricians, etc.) who may routinely encounter LA in homes and offices during their work. It is also recognized that homeowners and others may encounter LA during home renovation projects.

A special case, although not truly an indoor exposure, is breathing air inside a vehicle (car, truck) that has been contaminated with LA over time through open windows, especially at high source locations (e.g., Rainy Creek Road), or by tracking in LA-contaminated soil or dust from other locations on clothing or shoes.

3. *Breathing Outdoor Air Near a Soil Disturbance.* When a person engages in an activity that disturbs LA-contaminated soil, dust, or mine waste material, LA will be released into the air, with the highest levels occurring in the immediate proximity of the disturbance. Thus, the person causing the disturbance will usually have the highest exposure. This type of scenario may occur at a variety of residential, commercial, school, or recreational locations, and may include a very wide range of behaviors that disturb the soil, dust, or mine waste material. A few selected examples include:

   - A child playing in dirt in his/her yard
   - An adult performing home yard or garden care activities
   - Children or adults engaging in sports or exercise at schools or other public recreational facilities
   - A tradesperson installing or repairing buried utility lines

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- A tradesperson working on a roof that contains LA deposited from air fallout
- A visitor participating in recreational activities in OU4.

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Note that most individuals in Libby may be exposed by more than one of these pathways (Peipins et al. 2003). For example, a resident may be exposed while working in his/her yard, while indoors at his/her home, and while visiting public areas. For this reason, exposure and risk evaluations must consider the combined, or cumulative, effect of all exposure scenarios and pathways that apply to individuals in the community.

**REFERENCES**

Midwest Research Institute. 1982. Collection, analysis, and characterization of vermiculite samples for fiber content and asbestos contamination. Final report. Washington, DC; U.S. Environmental Protection Agency. Contract No. 68-01-5915.

Peipins LA, Lewin M, Campolucci S, Lybarger JA, Miller A, Middleton D, Weis C, Spence M, Black B, Kapil V. 2003. Radiographic Abnormalities and Exposure to Asbestos-Contaminated Vermiculite in the Community of Libby, Montana, USA. Environ Health Perspect 111:1753-1759.

USEPA. 1985. Exposure Assessment for Asbestos Containing Vermiculite. Report #560/5-85-013.

USEPA. 1989. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A). U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-89/002.

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